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(54) **CDMA COMMUNICATION SYSTEM AND ITS TRANSMISSION POWER CONTROL METHOD**

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(51) **Int. Cl.**[7] **H04B 7/185**; H04B 7/216
(52) **U.S. Cl.** **370/318**; 370/335
(58) **Field of Search** 379/318, 311, 379/320, 322, 332, 333, 335, 342; 455/69, 70, 115, 432, 522, 13.4

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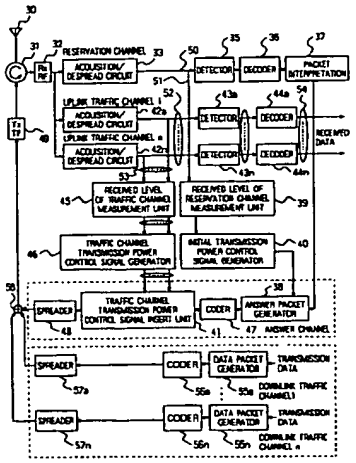
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(57) **ABSTRACT**

An uplink channel transmission power control method is provided for a CDMA mobile communication system performing one way communication. A base station measures the received level of data transmitted from each mobile terminal at each channel, and generates a transmission power control signal of each uplink traffic channel. The generated transmission power control signals are multiplexed, and the multiplexed common transmission power control signal is transmitted to all mobile terminals by using the common channel shared by the mobile terminals. Each mobile terminal derives the transmission power control signal of the uplink traffic channel used by the terminal, from the received common transmission power control signal, and controls the transmission power of a data packet.

25 Claims, 10 Drawing Sheets



PRIOR ART

FIG. 1

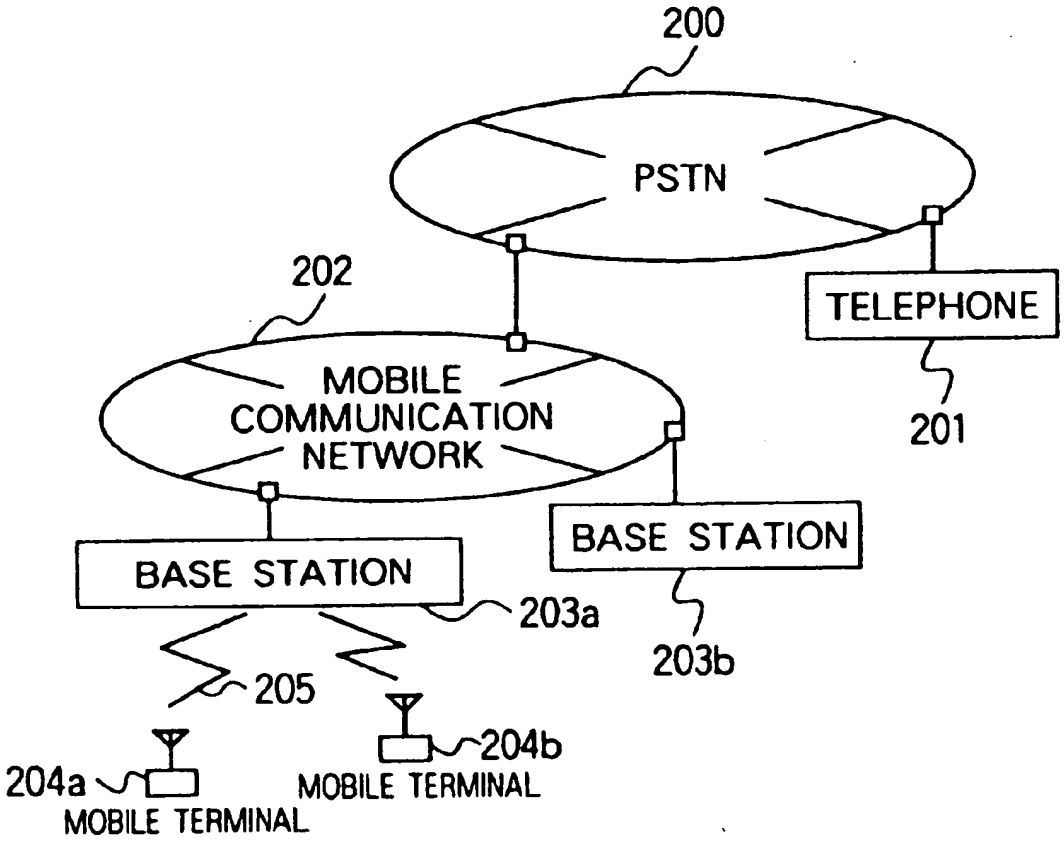


FIG. 2

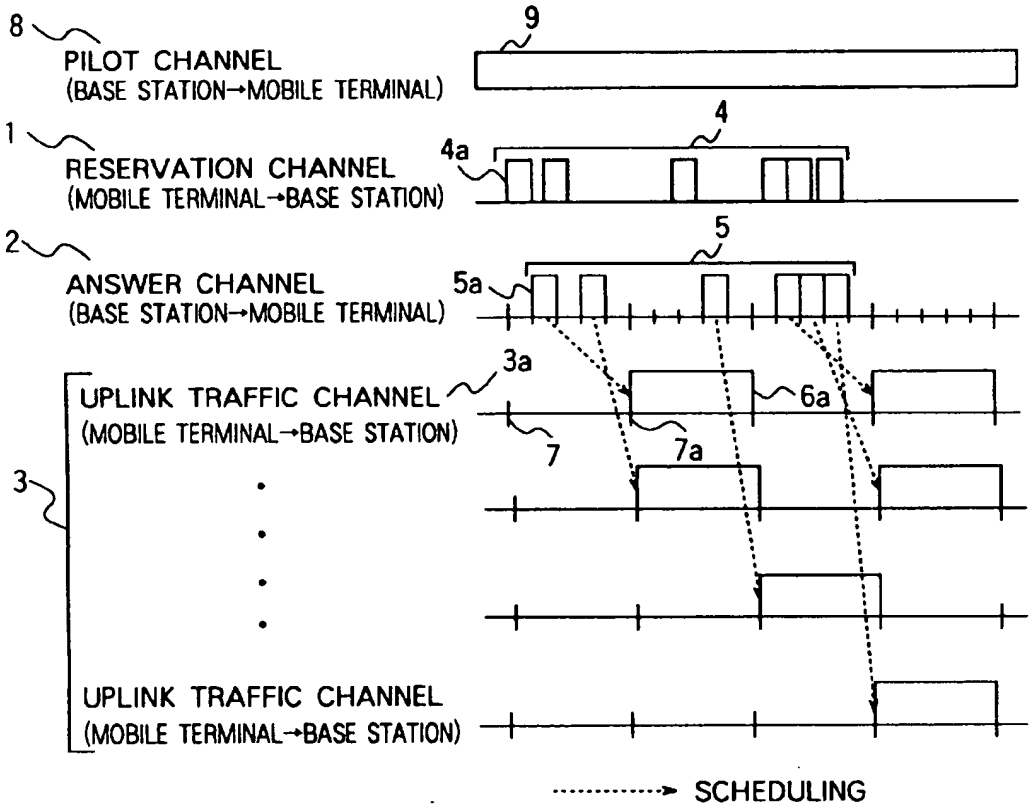

8
PILOT CHANNEL
(BASE STATION→MOBILE TERMINAL)
9
1
RESERVATION CHANNEL
(MOBILE TERMINAL→BASE STATION)
4a
4
2
ANSWER CHANNEL
(BASE STATION→MOBILE TERMINAL)
5a
5
3a
UPLINK TRAFFIC CHANNEL
(MOBILE TERMINAL→BASE STATION)
6a
7
7a
3
UPLINK TRAFFIC CHANNEL
(MOBILE TERMINAL→BASE STATION)
SCHEDULING

FIG. 3

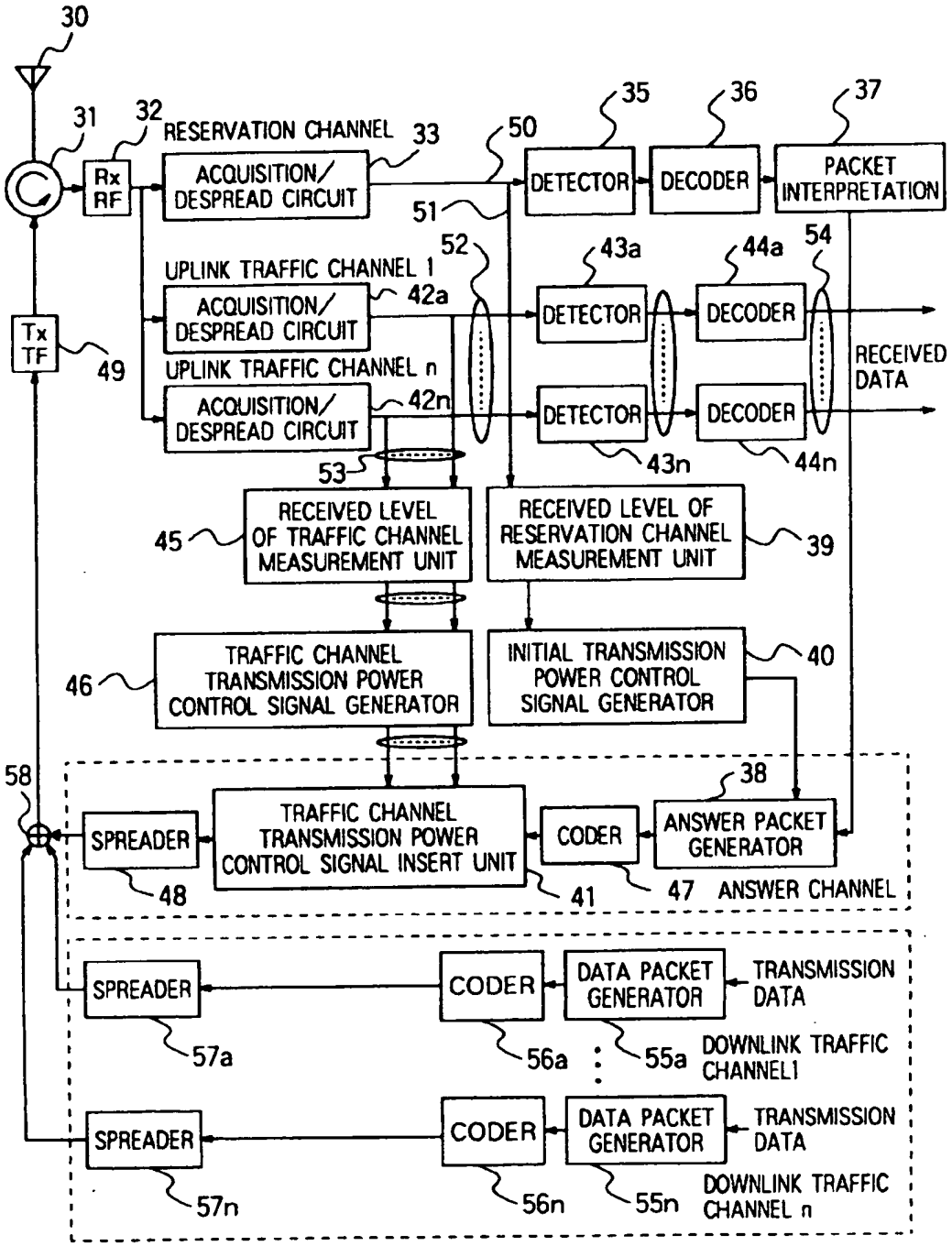

30
31
32
RESERVATION CHANNEL
33
50
35
36
37
Rx RF
ACQUISITION/ DESPREAD CIRCUIT
DETECTOR
DECODER
PACKET INTERPRETATION
51
52
43a
44a
54
UPLINK TRAFFIC CHANNEL 1
42a
ACQUISITION/ DESPREAD CIRCUIT
DETECTOR
DECODER
Tx TF
49
UPLINK TRAFFIC CHANNEL n
42n
RECEIVED DATA
ACQUISITION/ DESPREAD CIRCUIT
DETECTOR
DECODER
43n
44n
53
45
RECEIVED LEVEL OF TRAFFIC CHANNEL MEASUREMENT UNIT
RECEIVED LEVEL OF RESERVATION CHANNEL MEASUREMENT UNIT
39
46
TRAFFIC CHANNEL TRANSMISSION POWER CONTROL SIGNAL GENERATOR
INITIAL TRANSMISSION POWER CONTROL SIGNAL GENERATOR
40
58
38
SPREADER
TRAFFIC CHANNEL TRANSMISSION POWER CONTROL SIGNAL INSERT UNIT
CODER
ANSWER PACKET GENERATOR
48
41
47
ANSWER CHANNEL
SPREADER
CODER
DATA PACKET GENERATOR
TRANSMISSION DATA
57a
56a
55a
DOWNLINK TRAFFIC CHANNEL1
SPREADER
CODER
DATA PACKET GENERATOR
TRANSMISSION DATA
57n
56n
55n
DOWNLINK TRAFFIC CHANNEL n

FIG. 4

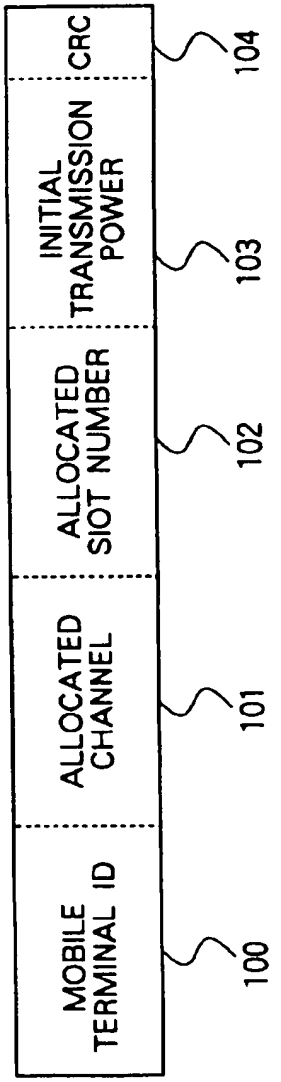

MOBILE TERMINAL ID
ALLOCATED CHANNEL
ALLOCATED SIOT NUMBER
INITIAL TRANSMISSION POWER
CRC
100
101
102
103
104

FIG. 5

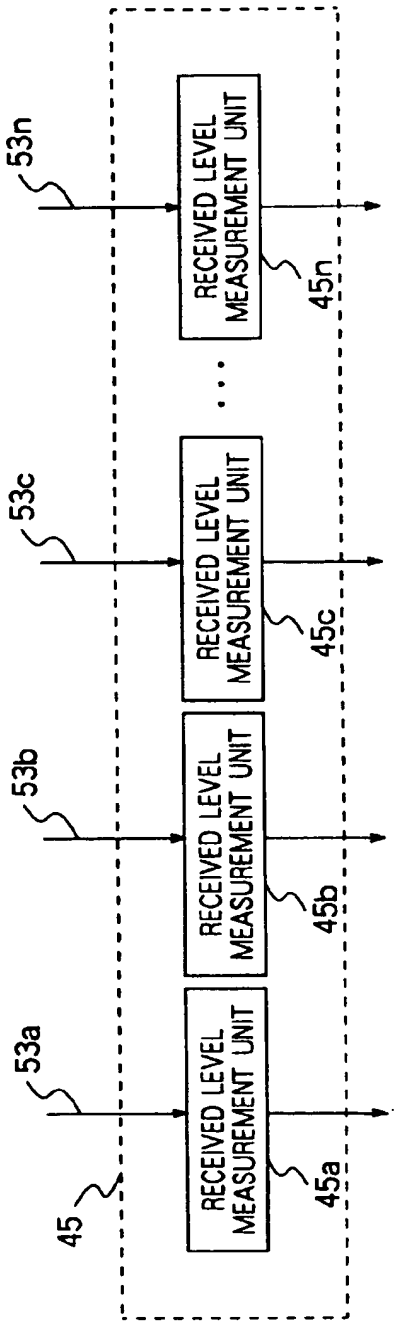

45
53a
53b
53c
53n
RECEIVED LEVEL MEASUREMENT UNIT
45a
45b
45c
45n

FIG. 6

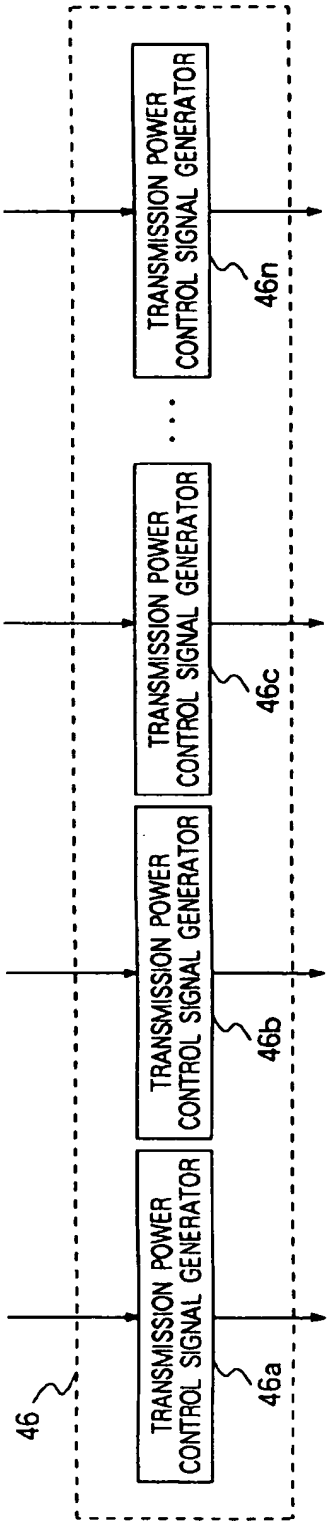

46
TRANSMISSION POWER CONTROL SIGNAL GENERATOR
46a
TRANSMISSION POWER CONTROL SIGNAL GENERATOR
46b
TRANSMISSION POWER CONTROL SIGNAL GENERATOR
46c
...
TRANSMISSION POWER CONTROL SIGNAL GENERATOR
46n

FIG. 7

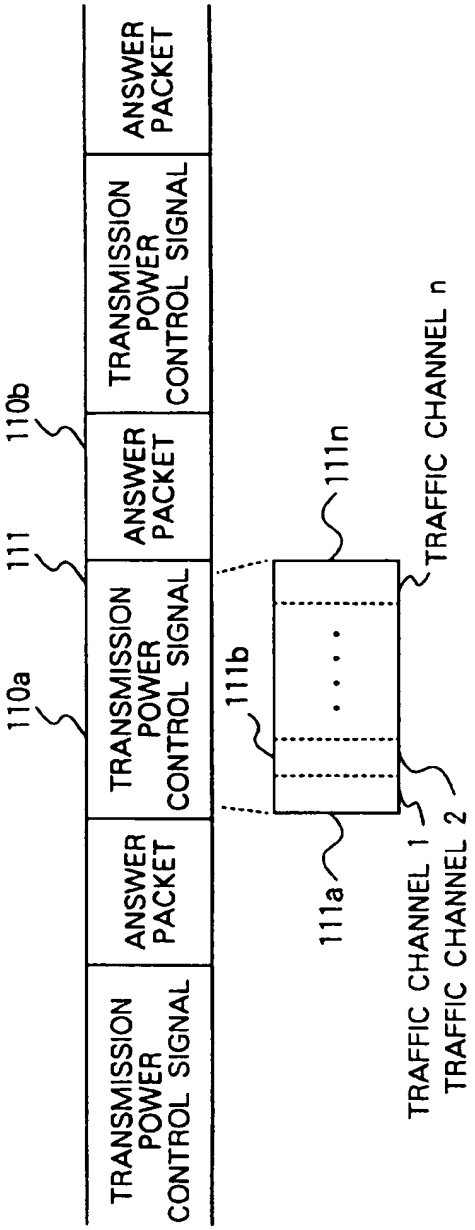

TRANSMISSION POWER CONTROL SIGNAL
ANSWER PACKET
TRANSMISSION POWER CONTROL SIGNAL
ANSWER PACKET
TRANSMISSION POWER CONTROL SIGNAL
ANSWER PACKET
110a
110b
111
111a
111b
111n
TRAFFIC CHANNEL 1
TRAFFIC CHANNEL 2
TRAFFIC CHANNEL n

FIG. 8

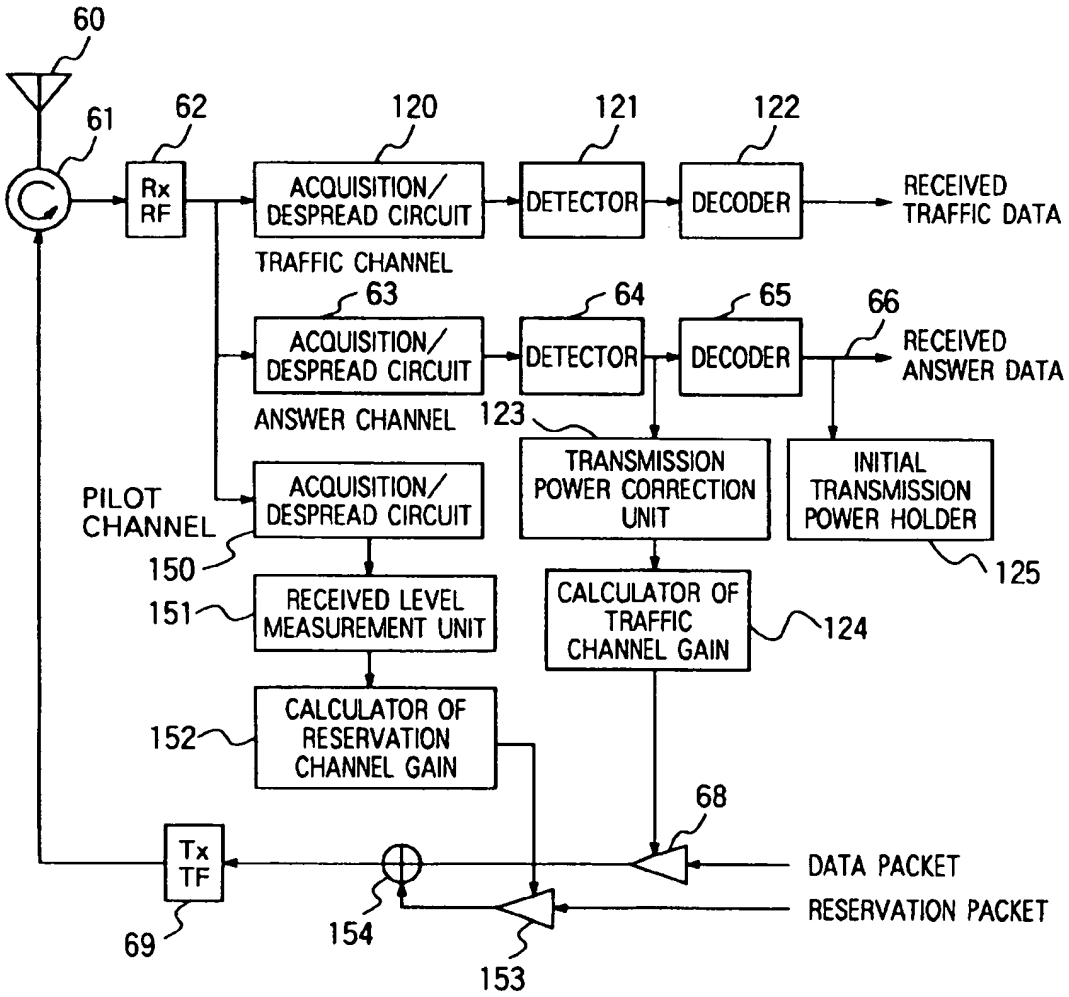

60
61
62
120
121
122
Rx RF
ACQUISITION/ DESPREAD CIRCUIT
DETECTOR
DECODER
RECEIVED TRAFFIC DATA
TRAFFIC CHANNEL
63
64
65
66
ACQUISITION/ DESPREAD CIRCUIT
DETECTOR
DECODER
RECEIVED ANSWER DATA
ANSWER CHANNEL
123
TRANSMISSION POWER CORRECTION UNIT
INITIAL TRANSMISSION POWER HOLDER
125
PILOT CHANNEL
ACQUISITION/ DESPREAD CIRCUIT
150
151
RECEIVED LEVEL MEASUREMENT UNIT
CALCULATOR OF TRAFFIC CHANNEL GAIN
124
152
CALCULATOR OF RESERVATION CHANNEL GAIN
68
Tx TF
DATA PACKET
RESERVATION PACKET
69
154
153

FIG. 9

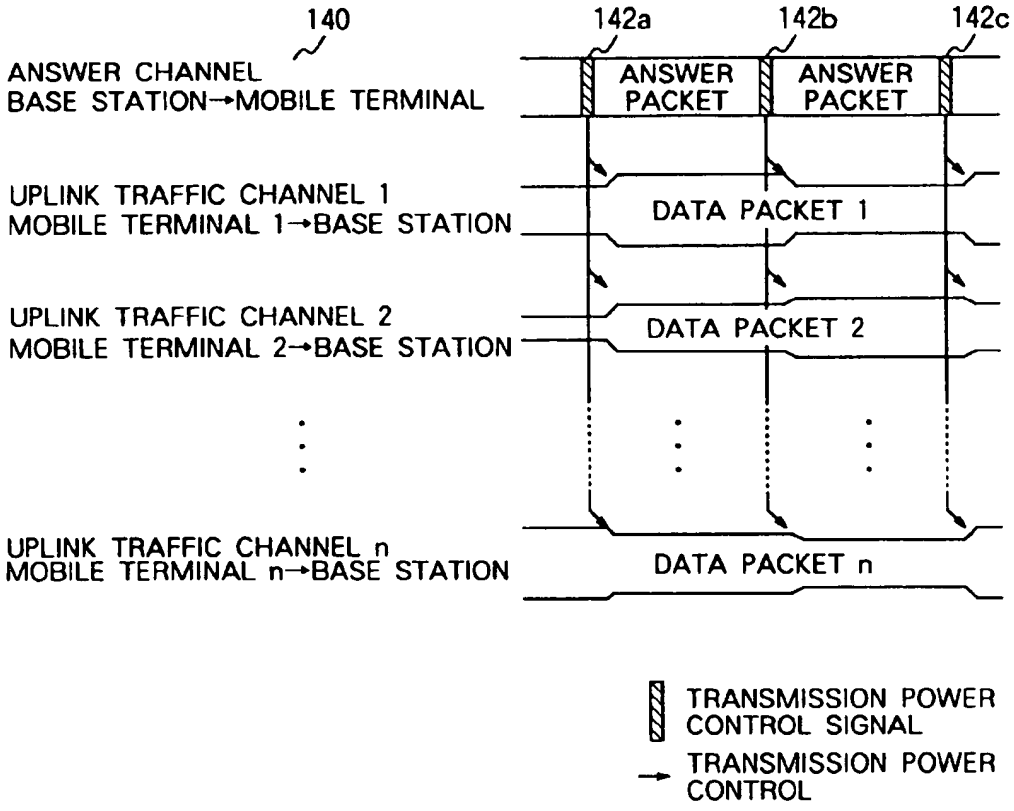

140
142a
142b
142c
ANSWER CHANNEL
BASE STATION→MOBILE TERMINAL
ANSWER PACKET
ANSWER PACKET
UPLINK TRAFFIC CHANNEL 1
MOBILE TERMINAL 1→BASE STATION
DATA PACKET 1
UPLINK TRAFFIC CHANNEL 2
MOBILE TERMINAL 2→BASE STATION
DATA PACKET 2
UPLINK TRAFFIC CHANNEL n
MOBILE TERMINAL n→BASE STATION
DATA PACKET n
TRANSMISSION POWER CONTROL SIGNAL
TRANSMISSION POWER CONTROL

FIG. 10

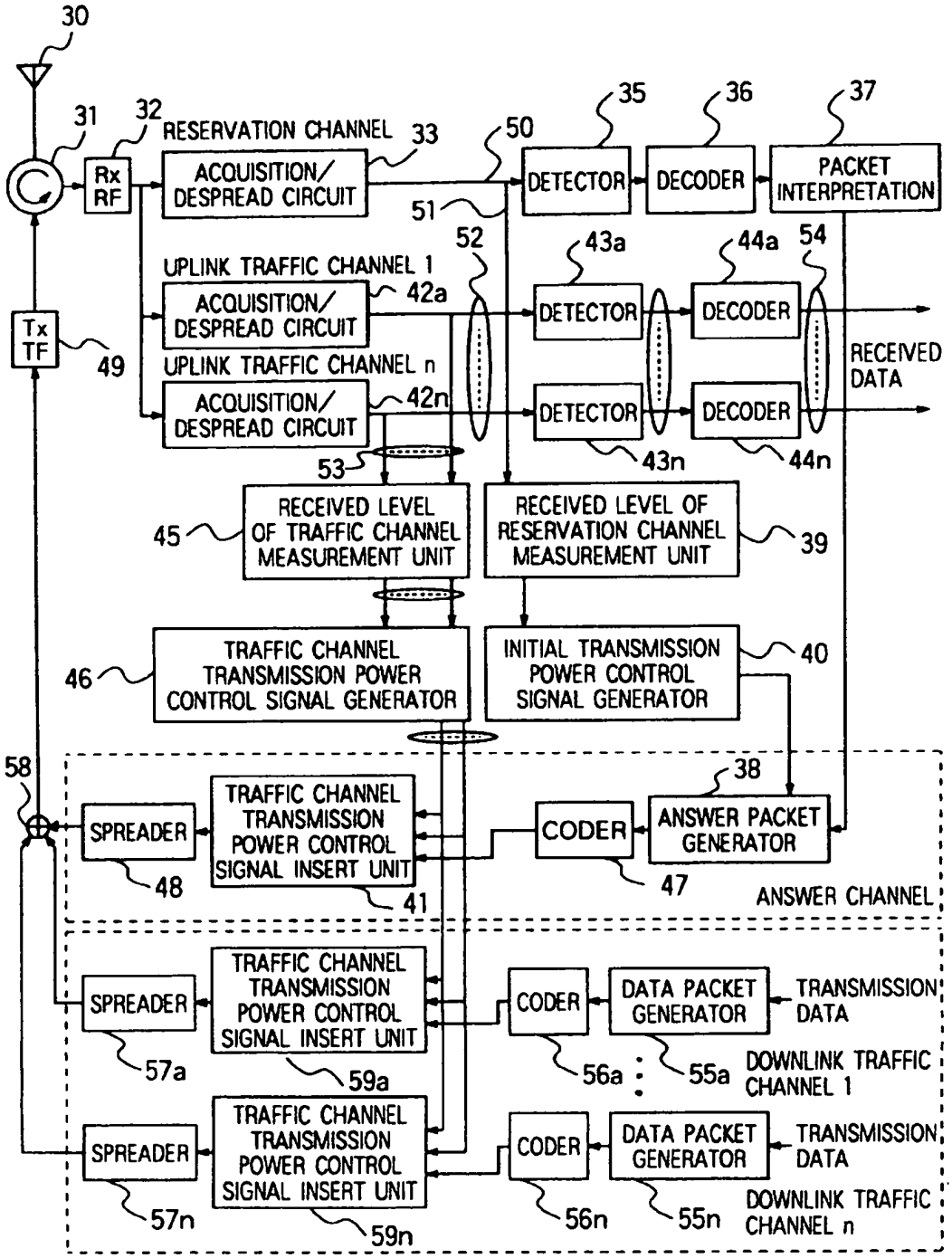

30
31
32
RESERVATION CHANNEL
33
Rx RF
ACQUISITION/ DESPREAD CIRCUIT
50
35
36
37
DETECTOR
DECODER
PACKET INTERPRETATION
51
52
UPLINK TRAFFIC CHANNEL 1
42a
43a
44a
54
ACQUISITION/ DESPREAD CIRCUIT
DETECTOR
DECODER
Tx TF
49
UPLINK TRAFFIC CHANNEL n
42n
RECEIVED DATA
ACQUISITION/ DESPREAD CIRCUIT
DETECTOR
DECODER
43n
44n
53
45
RECEIVED LEVEL OF TRAFFIC CHANNEL MEASUREMENT UNIT
RECEIVED LEVEL OF RESERVATION CHANNEL MEASUREMENT UNIT
39
46
TRAFFIC CHANNEL TRANSMISSION POWER CONTROL SIGNAL GENERATOR
INITIAL TRANSMISSION POWER CONTROL SIGNAL GENERATOR
40
58
38
SPREADER
TRAFFIC CHANNEL TRANSMISSION POWER CONTROL SIGNAL INSERT UNIT
CODER
ANSWER PACKET GENERATOR
48
41
47
ANSWER CHANNEL
SPREADER
TRAFFIC CHANNEL TRANSMISSION POWER CONTROL SIGNAL INSERT UNIT
CODER
DATA PACKET GENERATOR
TRANSMISSION DATA
57a
59a
56a
55a
DOWNLINK TRAFFIC CHANNEL 1
SPREADER
TRAFFIC CHANNEL TRANSMISSION POWER CONTROL SIGNAL INSERT UNIT
CODER
DATA PACKET GENERATOR
TRANSMISSION DATA
57n
59n
56n
55n
DOWNLINK TRAFFIC CHANNEL n

FIG. 11

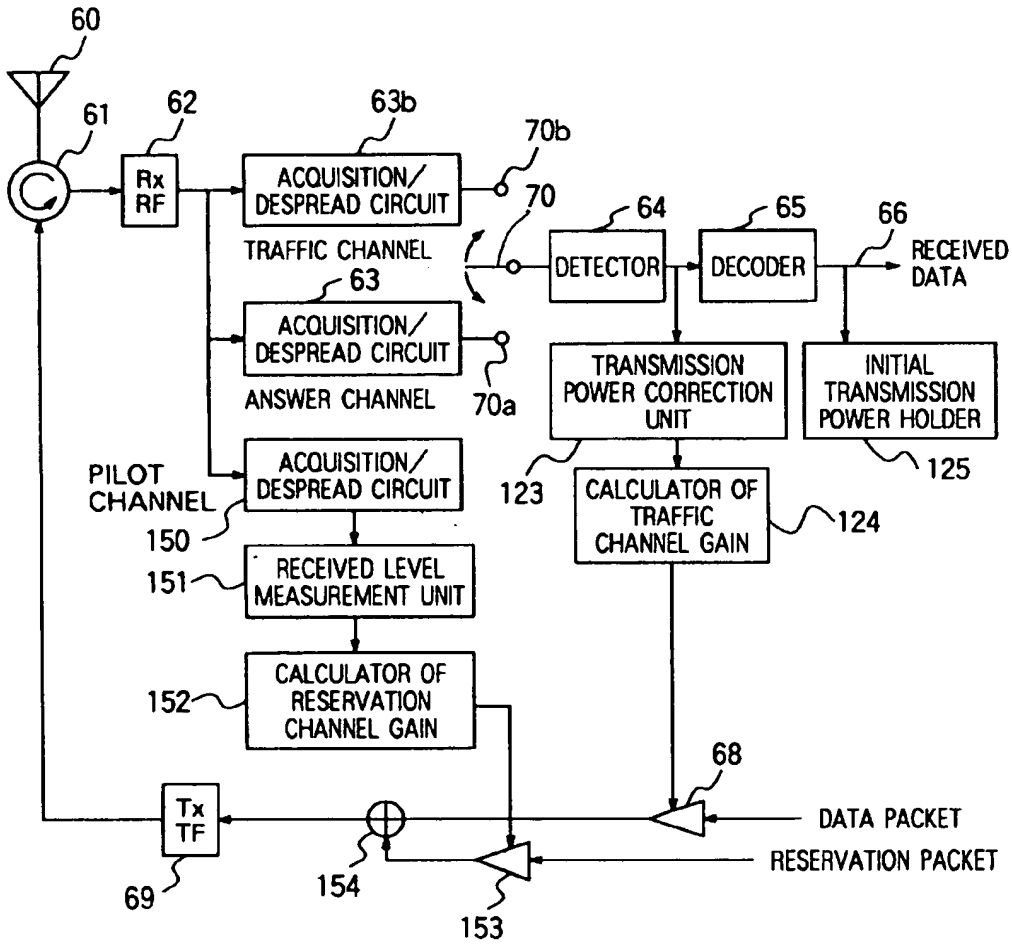
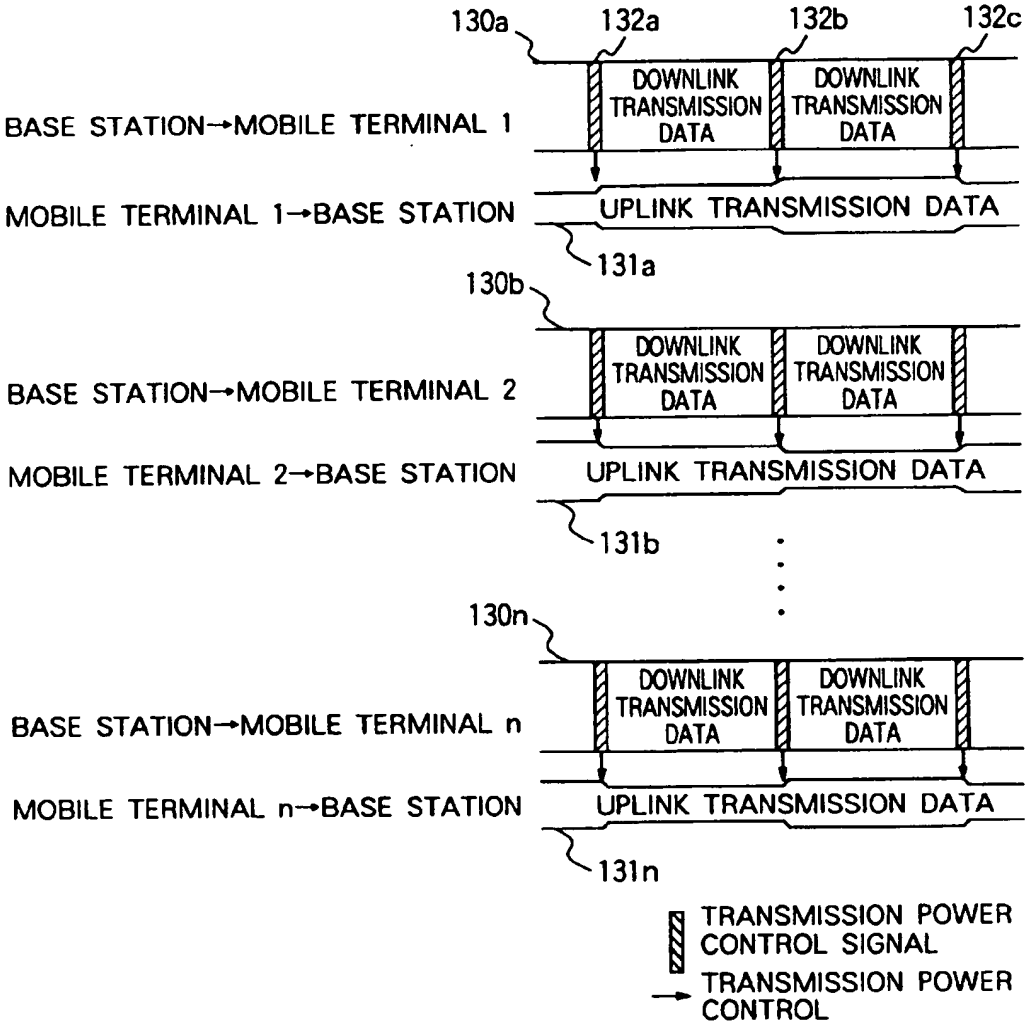

60
61
62
63b
70b
70
64
65
66
Rx RF
ACQUISITION/ DESPREAD CIRCUIT
TRAFFIC CHANNEL
DETECTOR
DECODER
RECEIVED DATA
63
ACQUISITION/ DESPREAD CIRCUIT
70a
ANSWER CHANNEL
TRANSMISSION POWER CORRECTION UNIT
INITIAL TRANSMISSION POWER HOLDER
125
PILOT CHANNEL
150
ACQUISITION/ DESPREAD CIRCUIT
123
CALCULATOR OF TRAFFIC CHANNEL GAIN
124
151
RECEIVED LEVEL MEASUREMENT UNIT
152
CALCULATOR OF RESERVATION CHANNEL GAIN
68
Tx TF
DATA PACKET
RESERVATION PACKET
69
154
153

FIG. 12


130a
132a
132b
132c
DOWNLINK TRANSMISSION DATA
DOWNLINK TRANSMISSION DATA
BASE STATION→MOBILE TERMINAL 1
MOBILE TERMINAL 1→BASE STATION
UPLINK TRANSMISSION DATA
131a
130b
DOWNLINK TRANSMISSION DATA
DOWNLINK TRANSMISSION DATA
BASE STATION→MOBILE TERMINAL 2
MOBILE TERMINAL 2→BASE STATION
UPLINK TRANSMISSION DATA
131b
130n
DOWNLINK TRANSMISSION DATA
DOWNLINK TRANSMISSION DATA
BASE STATION→MOBILE TERMINAL n
MOBILE TERMINAL n→BASE STATION
UPLINK TRANSMISSION DATA
131n
TRANSMISSION POWER CONTROL SIGNAL
TRANSMISSION POWER CONTROL

CDMA COMMUNICATION SYSTEM AND ITS TRANSMISSION POWER CONTROL METHOD

BACKGROUND OF THE INVENTION

The present invention relates to a code division multiple access mobile communication system and its transmission power control method. More particularly, the present invention relates to a packet communication system and its transmission power control method using reservation based access control.

In a CDMA method, a plurality of mobile terminals share the same frequency band to communicate with a single base station. Therefore, for example, if mobile terminals A and B transmit modulated signal waves to the base station, the signal (not desired to be received) transmitted by the mobile terminal B interferes with the signal (desired to be received) transmitted by the mobile terminal A, and the communication of the mobile terminal A with the base station is obstructed. The degree of interference depends on the received level of a signal (not desired to be received) at the base station. If the degree of interference becomes large to some level or more, communication between the mobile terminal and base station becomes impossible.

If the transmission power of each mobile terminal can be controlled to always limit the signal level received at the base station to a minimum necessary reception power, it becomes possible to maximize the number of channels capable of being communicated by the base station. The more the transmission power shifts from the minimum necessary reception power, the less the number of channels capable of being communicated by the base station.

As transmission power control techniques of CDMA mobile communication, an IS-95 transmission power control method is known described in TIA/EIA/IS-95 which is a standard system of digital cellular phones adopted in North America. The IS-95 transmission power control method will be described in the following.

Since two way communication is essential for cellular phones, a pair of an uplink traffic channel and a downlink traffic channel is used for the communication between the base station and a mobile terminal. The uplink traffic channel is a channel for transmitting data from a mobile terminal to the base station, and a downlink traffic channel is a channel for transmitting data from the base station to the mobile terminal.

The base station measures the reception power of data transmitted from each mobile terminal and generates a transmission power control signal in accordance with the measured reception power. If the reception power of data is larger than a target reception power, the base station generates a transmission power control signal "1" for this mobile station. Conversely if the reception power of data is smaller than the target reception power, the base station generates a transmission power control signal "0" for this mobile station. The generated transmission power control signal is inserted into data to be transmitted from the base station to a mobile terminal, and the transmission data with the transmission power control signal is transmitted to the mobile terminal. The mobile terminal controls to reduce the transmission power if the received transmission power control signal is "1", and to increase it if "0".

This transmission power control will be described specifically with reference to FIG. 12. Each mobile terminal 1 to n and the base station communicate with each other by using a pair of an uplink traffic channel and a downlink traffic channel. The upper row of each pair represents transmission data of the downlink traffic channel, and the lower row represents transmission data of the uplink traffic channel. The width of transmission data, particularly uplink transmission data, is drawn to correspond to a reception power of the uplink data at the base station.

When the base station communicates with the mobile terminal 1, it inserts transmission power control signals **132***a*, **132***b*, **132***c*, . . . into a downlink traffic channel **130***a* to the mobile terminal 1. The mobile terminal 1 changes its transmission power of the uplink transmission data in accordance with the transmission power control signal obtained from the received channel **130***a*. As above, the transmission power control of the mobile terminal 1 is performed by using the downlink traffic channel **130***a*. Similar transmission power control is performed also for other mobile terminals 2 to n.

SUMMARY OF THE INVENTION

With advancement of mobile communication techniques, needs of not only a voice communication function (cellular phone) but also a data communication function are becoming large.

For one way communication typical to data communication, CDMA packet communication systems have been proposed from the viewpoint of efficiently using channels. One proposal of such CDMA packet communication systems is described in "Development on CDMA Packet Mobile Communication System" by Yano, Uta, Hasegawa, and Doi, Communication Society Meeting, the Institute of Electronics, Information and Communication Engineers, B-389 (1996).

Voice communication is two way communication using uplink and downlink traffic channels, whereas data communication is one way communication using only one of uplink and downlink traffic channels. In such one way communication, a conventional transmission power control method for cellular phones cannot be adopted because this method is established on the assumption that there is a pair of uplink and downlink traffic channels.

If a paired downlink channel is provided only for the transmission power control of the uplink traffic channel, one downlink traffic channel is occupied by the transmission power control of only the uplink traffic channel. The use efficiency of traffic channels is lowered.

To solve this problem, the invention provides a CDMA packet data communication system in which a base station controls the transmission power of each of a plurality of mobile terminals by using a single downlink traffic channel common for all mobile stations.

The base station measures the received level of data transmitted from each mobile terminal at each channel, and generates a transmission power control signal of each channel in accordance with the measured reception level. The generated transmission power control signals are collected together into a format predetermined for the system, and transmitted to all mobile terminals by using the common channel shared by the mobile terminals.

Each mobile terminal derives the transmission power control signal of the uplink traffic channel used by the terminal, from the collected transmission power control signals transmitted from the base station, and transmits data at the transmission power changed in accordance with the derived transmission power control signal.

These and other objects, features and advantages of the present invention will become more apparent in view of the

following detailed description of the preferred embodiments in conjunction with accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a diagram showing the structure of a mobile communication network.

FIG. **2** is a diagram illustrating a packet data communication system using reservation based access control.

FIG. **3** is a diagram showing a first example of the structure of a base station embodying transmission power control of the present invention.

FIG. **4** is a diagram showing the structure of an answer packet.

FIG. **5** is a diagram showing the structure of a unit for measuring a received level of a traffic channel.

FIG. **6** is a diagram showing the structure of a unit for generating a transmission power control signal of a traffic channel.

FIG. **7** is a diagram illustrating insertion of a transmission power control signal between answer packets.

FIG. **8** is a diagram showing a first example of the structure of a mobile terminal embodying the transmission power control of the invention.

FIG. **9** is a diagram illustrating a transmission power control state of an uplink traffic channel realized by the operations of a base station and mobile terminals according to the present invention.

FIG. **10** is a diagram showing a second example of the structure of a base station embodying the transmission power control of the invention.

FIG. **11** is a diagram showing a second example of the structure of a mobile terminal embodying the transmission power control of the invention.

FIG. **12** is a diagram illustrating an uplink traffic channel transmission power control method of a conventional portable telephone system.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. **1** shows the structure of a mobile communication network applied to the present invention. A public switched telephone network (PSTN) **200** is connected with a fixed terminal **201** such as a telephone and a mobile communication network **202**. The mobile communication network **202** is connected with a plurality of base stations **203***a*, **203***b*, . . . Each base station **203** communicates with mobile terminals **204***a*, **204***b*, . . . in its service area (cell) via radio channels **205**.

In the following, the invention will be detailed by applying it to a CDMA packet communication system using reservation based access control shown in FIG. **2**.

In the CDMA packet communication system using reservation based access control, channels shared by a plurality of mobile terminals in the service area include a reservation channel **1** (uplink channel), an answer channel **2** (downlink channel) and a pilot channel **8** (downlink channel). The pilot channel **8** is a channel used for transmitting a pilot signal **9** as a reference signal to each mobile terminal.

A mobile terminal having a data transmission request transmits a reservation packet **4** at a desired timing by using the reservation channel **1**. The base station performs scheduling of received reservation packets. The base station selects (schedules) a channel and a time slot (a time slot **7** is defined in an uplink traffic channel **3**) via which each mobile terminal can transmit data, from a plurality of uplink traffic channels **3**. In order to transmit the scheduling results to each mobile terminal, the base station generates an answer packet **5** corresponding to the reservation packet. The generated answer packet **5** is transmitted to the corresponding mobile terminal in the area by using the answer channel **2**. The mobile terminal identifies the answer packet destined to it from received answer packets **5**, and transmits a data packet by using the uplink traffic channel and time slot designated by the base station.

In the example shown in FIG. **2**, the mobile terminal transmitted the reservation packet **4***a* receives the answer packet **5***a* transmitted to it, selectively from answer packets transmitted from the base station, and transmits a data packet **6***a* by using the time slot **7***a* of the traffic channel **3***a* designated in the received answer packet **5***a*.

With reference to FIGS. **3** to **9**, a first embodiment will be described which realizes a method of controlling the transmission power of an uplink channel.

FIG. **3** shows an example of the structure of a base station. A signal received by an antenna **30** is input via a circulator **31** to a reception radio module **32**. The reception radio module **32** performs a high/middle frequency reception process to demodulate a signal in a carrier frequency band into a baseband signal. Since the received signal has a plurality of multiplexed channel signals, it is input to an acquisition/despread circuit (**33**, **42***a*–**42***n*) to be spectrum despread.

A reservation channel output from the reservation channel acquisition/despread circuit **33** is supplied via a signal line **50** to a detector **35** whereat it is detected and then supplied to a decoder **36** whereat an error correction decode process such as Viterbi decoding is performed. A packet interpretation unit **37** interprets the decoded reservation packet to obtain a terminal ID of the mobile terminal which transmitted the reservation packet and the reservation contents such as transmission data, and transfers the reservation contents to an answer packet generator unit **38**.

The reservation packet is also input via a signal line **51** to a unit **39** for measuring the received level of the reservation channel. This unit **39** measures a signal to noise power ratio (SN ratio) of the reservation packet. The measurement result of the received level is compared with a reference reception level by an initial transmission power control signal generator **40**. In accordance with this comparison result, a transmission power control signal is generated which designates a transmission power when the mobile terminal starts transmitting a data packet. The generated transmission power control signal is input to an answer packet generator **38**.

In accordance with the reservation contents interpreted by the packet interpretation unit **37** and the transmission power control signal generated by the initial transmission power control signal generator **40**, the answer packet generator **38** generates an answer packet. An example of the structure of an answer packet is shown in FIG. **4**. A mobile terminal ID is an ID of a mobile terminal which transmitted a reservation packet. This ID is used as a destination of the answer packet. An allocated channel **101** and an allocated slot number **102** indicate an uplink traffic channel and a time slot to be used by the mobile terminal and are designated by the answer packet generator **38**. An initial transmission power **103** indicates a transmission power when the mobile terminal starts transmitting data and is designated by the transmission power control signal input from the initial transmission power control signal generator **40**. This initial transmission

power control signal may designate an increase/decrease relative to the transmission power when the reservation packet was transmitted, or may be an absolute value (increased/decreased value) of the transmission power, whichever of them is determined by the system. A CRC (Cyclic Redundancy Check) **104** is a code added to the answer packet for error detection/correction.

The answer packet generated in the above manner is input to a coder **47** whereat an error correction coding such as convolutional coding is performed. The coded answer packet is input to a unit **41** for inserting a traffic channel transmission power control signal.

The other acquisition/despread circuits **42***a* to **42***n* provided for a plurality of uplink traffic channels each output a data packet transmitted via each uplink traffic channel. The data packet of each channel is supplied via a signal line **52** to a detector **43***a*–**43***n* and a decoder **44***a* to **44***n* to be detected and decoded, and the reception data is output from a signal line **54**.

The data packet is also supplied via a signal line **53** to a unit **45** for measuring the received level of the traffic channel. The structure of this unit **45** is shown in FIG. **5**. The received level measurement units **45***a* to **45***n* corresponding to the uplink traffic channels **53***a* to **53***n* measure the received level such as an SN ratio.

The received level measurement result of each traffic channel is input to a traffic channel transmission power control signal generator **46**. The structure of the generator **46** is shown in FIG. **6**. Each of the transmission power control signal generators **46***a* to **46***n* provided for each uplink traffic channel compares the received level with a target reception level, and generates a transmission power control signal for making the mobile terminal renew the transmission power when it continues data transmission. Similar to the initial transmission power control signal, this renewal designation transmission power control signal is determined by the system. The generated transmission power control signal is input to the unit **41** for inserting the traffic channel transmission power control signal.

As shown in FIG. **7**, the traffic channel transmission power control signal insert unit **41** inserts a common transmission power control signal **111** generated by the traffic channel transmission power control signal generator **46** at a predetermined interval between answer packets **110** input from the answer packet generator **38**. The common transmission power control signal **111** is constituted of transmission power control signals **111***a* to **111***n* of respective traffic channels **1** to n.

In order to suppress a fluctuation of the received level of a data packet, the base station is required to perform a transmission power control of each mobile terminal at a sufficiently high occurrence frequency. The data packet is made of several tens of bits to allow information of some amount to be transmitted at the same time. In contrast, the common transmission power control signal **111** can be made of n bits assuming the same system as IS-95. As shown in FIG. **4**, the answer packet can be made sufficiently small relative to the size of a data packet. Therefore, as in this embodiment, even if the answer channel and the transmission power control channel are shared, the transmission power control can be performed at a sufficiently high occurrence frequency. If the answer packet and the common transmission power control signal are received by the same channel, the mobile terminal can use a common receiver both for the answer packet and common transmission power control signal. In this manner, the circuit scale of each mobile terminal can be made small.

It is also possible to transmit the common transmission power control signal at a transmission power larger than that of the answer packet in order to reliably perform the transmission power control.

The answer packet and common transmission power control signal are spectrum spread by a spreader **48** for answer channel. The spectrum spread answer packet and common transmission power control signal are multiplexed with other downlinks by an adder **58**, modulated from the baseband signal into a signal in the carrier frequency band by a transmission radio module **49**, and transmitted from the antenna **30** via the circulator **31**.

An example of the structure of a mobile terminal is shown in FIG. **8**.

The operation of transmitting a reservation packet from a mobile terminal will be described.

A signal received by an antenna **30** is input via a circulator **61** to a reception radio module **62**. The reception radio module **62** performs a high/middle frequency reception process to demodulate a signal in the carrier frequency band into a baseband signal. A pilot signal output from an acquisition/spread circuit **150** for a pilot channel is input to a unit **151** for measuring a received level. This unit **151** measures the received level (e.g., SN ratio) of the pilot signal. The measurement result of the received level is input to a reservation channel gain calculator **152** which determines the transmission power of a reservation packet in accordance with the received level of the pilot signal.

In the mobile communication system provided with independent pilot channels, the pilot signal is transmitted from the base station always at a constant transmission power level. Therefore, if an SN ratio of the received pilot signal is large, it is conceivable that the mobile terminal is near at the base station so that the reservation channel gain calculator **152** calculates a small gain. Conversely, if an SN ratio of the received pilot signal is small, it is conceivable that the mobile terminal is far from the base station so that the reservation channel gain calculator **152** calculates a large gain. In order to determine the transmission power of a reservation packet in the above manner, another signal different from the pilot signal may be used so long as it allows the mobile terminal to know the transmission power of the base station. For example, the pilot signal whose transmission power is determined by the system or a control signal transmitted with the transmission power value can satisfy the above conditions.

Next, an operation will be described in which a mobile terminal that transmitted a reservation packet to the base station receives an answer packet transmitted from the base station.

An answer packet output from the despread circuit **63** for an answer channel is detected with a detector and subjected to an error correction/decode process such as Viterbi decoding. With the above processes, it becomes possible to obtain the information of an allocated traffic channel and an allocated time slot contained in the answer packet. An initial transmission power holder **125** holds an initial transmission power signal contained in the answer packet, and inputs the initial transmission power signal to a data channel gain calculator **124** which calculates a gain so that a data packet can be transmitted at a transmission power designated by the initial transmission power signal. The calculated gain is set as the gain of a variable gain amplifier **68**.

The data packet transmitted from the mobile terminal is amplified by the variable gain amplifier **68** at the gain designated by the data channel gain calculator **124**. The

amplified signal is modulated from the baseband signal into a signal in the carrier frequency band by a transmission radio module **69** and transmitted from the antenna **60** via the circulator **61**.

Next, transmission power control while a mobile terminal transmits a data packet to the base station will be described.

A transmission power correction unit **123** derives the common transmission power control signal from a signal of the answer channel processed by the answer channel acquisition/despread circuit **63** and detector **64**. The transmission power correction unit **123** selects a transmission power control signal of the uplink traffic channel now in use by its mobile terminal, from the common transmission power control signal. For example, in the example shown in FIG. **7**, the mobile terminal transmitting a data packet by using the transmission channel **1** selects its transmission power control signal **111***a*. The selected transmission power control signal is input to the gain calculator **124** which calculates a gain so that a data packet can be transmitted at a transmission power designated by the transmission control signal, and thereafter renews the gain of the variable gain amplifier **68**. The amplified signal is modulated by the transmission radio module **69** from the baseband signal into a signal in the carrier frequency band, and transmitted from the antenna **60** via the circulator **61**.

FIG. **9** illustrates the state of transmission power control realized by the above operations of the base station and a mobile terminal.

The base station inserts common transmission power control signals **142***a*, **142***b*, **142***c*, . . . into a common answer channel shared by mobile terminals in the area and transits them. The common transmission power control signal **142** contains transmission power control signals for the respective traffic channels **1** to n. Each of the mobile terminals **1** to n transmitting data packets **1** to n to the base station derives the transmission power control signal of the traffic channel now in use by the mobile terminal, from the common transmission power control signals **142***a*, **142***b*, **142***c*, . . . In accordance with the derived transmission power control signal, the mobile terminal changes the transmission power of the data packet.

In the state shown in FIG. **9**, the width of a data packet is drawn to correspond to the receive level of the data packet at the base station. For example, in the uplink traffic channel **1**, the mobile terminal controls the transmission power such that the transmission powers are increased, reduced, and increased in response to the reception of the common transmission power control signals **142***a*, **142***b*, and **142***c*.

While a data packet is not transmitted by a mobile station, the transmission power control signal is neglected. The transmission power control signal is also neglected if it is received before a lapse time (called "control delay time") necessary for measuring the received level of a data packet at the base station after the mobile terminal transmitted the data packet. The reason for this is a possibility that the transmission power control information received before the lapse of the control delay time may be the transmission power control information of a data packet transmitted by another mobile terminal resulting in erroneous control to be made.

With the above operations, it becomes possible for the base station to perform transmission power control of the uplink traffic channels **1** to n by using the common control channel shared by the mobile terminals.

This first embodiment has the structure suitable for data communication, particularly for one way data communication. Two way data communication is performed in some case. In this case, the transmission power control signal may be contained in data of a downlink traffic channel. In the following, a mobile communication system of the second embodiment will be described which is suitable for two way communication and has a simple circuit structure, particularly of a mobile terminal.

FIG. **10** shows an example of the structure of a base station according to the second embodiment.

In FIG. **10**, like constituent elements to those of the base station of the first embodiment are represented by identical reference numerals. The operation of the base station when a reservation packet is received is similar to the first embodiment.

The base station operates in the manner similar to the first embodiment to decode a received data packet and obtain reception data from the signal line **54**. The unit **45** for measuring the received level of a traffic channel and the traffic channel transmission power control signal generator **46** generate transmission power control signals of respective uplink traffic channels.

In the second embodiment, if a mobile terminal transmits and receives a data packet to and from the base station by using an uplink traffic channel i and a down-link traffic channel k, the base station inputs the transmission power control signal of the uplink traffic channel i to the traffic channel transmission power control signal insert unit **59** of the downlink traffic channel k to insert the transmission power control signal into the data packet.

The operation will be detailed by taking as an example the case wherein the base station transmits a data packet by using a downlink traffic channel n to a mobile terminal which transmits a data packet to the base station by using an uplink traffic channel **1**. In this case, the transmission power control signal of the uplink traffic channel **1** generated by the traffic channel transmission power control signal generator **46** is input to a traffic channel transmission power control signal insert unit **59***n* of the downlink transmission channel n. The traffic channel transmission power control signal insert unit **59***n* inserts the transmission power control signal in the data packet. This data packet is spectrum spread by the spreader **57***n* and multiplexed with other channel signals by the adder **58**. The multiplexed signal is modulated by the transmission radio module **49** from the baseband signal into a signal of the carrier frequency band, and transmitted from the antenna **30** via the circulator **31**.

An example of a mobile terminal of the second embodiment is shown in FIG. **11**.

In FIG. **11**, like constituent elements to those of the mobile terminal of the first embodiment shown in FIG. **8** are represented by identical reference numerals. A switch **70** is connected to **70***a* to perform similar operations to the first embodiment, if the mobile terminal transmits a reservation packet, receives an answer packet transmitted from the base station, or only transmits a data packet to the base station (one way communication).

Next, an operation (two way communication) will be described in which a mobile terminal transmits and receives a data packet to and from the base station. In this case, the switch **10** is turned to the **70***b* side.

A data packet is received via the antenna **60**, circulator **61** and reception radio module **62**, and subjected to a reception process by the traffic channel acquisition/despread circuit **63***b* and detector **64**. The data packet output from the detector is subjected to error correction/decoding by the decoder **65** to obtain reception data from the signal line **66**.

The data packet is also input to the transmission power correction unit **123** which derives the transmission power control signal inserted in the data packet and inputs it to the traffic channel gain calculator **124**. The traffic channel gain calculator **124** calculates a gain of the variable gain amplifier **68** to renew the gain, similar to the first embodiment.

With the base station and mobile terminals having the above structures and operating in the above manner, it becomes possible for a mobile terminal to perform transmission/reception of a data packet to/from the base station and reception of transmission power control by the base station, by using either the answer channel or traffic channel. Therefore, it is sufficient if only the mobile terminal has one set of a detector and a decoder, and so the circuit scale of the mobile terminal can be prevented from becoming large.

In the above embodiments, the invention has been applied to a mobile communication system of a reservation based access control scheme in which a base station transmits a transmission power control signal to each mobile terminal by using an answer channel. The invention is also applicable to a channel other than the answer channel if it is a common channel shared by mobile terminals. Namely, if a system uses a common channel shared by mobile terminals, the base station can perform transmission power control of a plurality of mobile terminals by transmitting transmission power control signals via the single common channel. Obviously, a channel dedicated to transmission power control may be provided to perform transmission power control of mobile terminals by transmitting transmission power control signals from the base station by using this dedicated channel.

While the present invention has been described above in conjunction with the preferred embodiments, one of ordinary skill in the art would be enabled by this disclosure to make various modifications to this embodiment and still be within the scope nd spirit of the invention as defined in the appended claims.

What is claimed is:

1. A transmission power control method for a CDMA communication system, comprising: a base station and a plurality of mobile terminals

performing communication by CDMA;

a plurality of said mobile terminals transmitting over uplink traffic channels to said base station;

said base station measuring the reception level of a signal transmitted from each of said plurality of mobile terminals, generating a transmission control signal in accordance with the reception level and a common transmission power control signal containing said transmission power control signals of said plurality of mobile terminals; spreading said common transmission power control signal with a spreader, and transmitting said spread common transmission power control signal through a common channel shared by said mobile terminals;

each of said plurality of mobile terminals receiving said common transmission power control signal, deriving a corresponding one of said transmission power control signals from said common transmission power control signal, and controlling the transmission power of a signal to be transmitted to said base station in accordance with said derived transmission power control signal.

2. A transmission power control method according to claim **1**, wherein said transmission power control signal is a signal indicating an increase/decrease of said transmission power and obtained through comparison between said reception level and a predetermined reference reception level.

3. A transmission power control method for a CDMA communication system which performs communication between a base station and a plurality of mobile terminals by CDMA, wherein:

said plurality of channels includes first channels allocated to said mobile terminals for transmitting a data packet to said base station and a second channel used by said base station, said second channel being shared by said plurality of mobile terminals;

said base station measures the reception level of a signal received at each of said first channels, generates a transmission power control signal in accordance with the reception levels and a common transmission power control signal containing said transmission power control signals of said plurality of mobile terminals, spreads said common transmission power control signal with a spreader, and transmits said spread common transmission power control signal through a said second channel shared by said mobile terminals; and

each of said plurality of mobile terminals receives said transmission power control signal destined thereto at said second channel, and controls the transmission power of a signal to be transmitted via a corresponding one of said first channels in accordance with said received transmission power control signal.

4. A transmission power control method according to claim **3**, wherein each of said first channels is allocated to each of said plurality of mobile terminals, said base station comprises third channels for transmitting data packets to said plurality of mobile terminals, and either a pair of said first channel and said third channel or only said first channel is allocated by said base station to said plurality of mobile terminals.

5. A transmission power control method for communication system which performs communication between a base station and a plurality of mobile terminals by CDMA, wherein:

a plurality of said mobile terminals transmit over uplink traffic channels to said base station;

said base station measures the reception level of a signal transmitted from each of said plurality of mobile terminals, generates a transmission power control signal in accordance with the reception level and a common transmission power control signal containing said transmission power control signals of mobile terminals performing one way communication, said common transmission power control signal is spread with a spreader, and said base station transmits said spread common transmission power control signal through a common channel shared by said mobile terminals and transmits a transmission signal containing a transmission power control signal of a mobile station performing two way communication thereto; and

each of said plurality of mobile terminals receives said common transmission power control signal or said transmission signal, derives a corresponding one of said transmission power control signals destined thereto from said common transmission power control signal or from said transmission signal, and controls the transmission power of a signal to be transmitted to said base station in accordance with said derived transmission power control signal.

6. A CDMA communication system for performing CDMA communication between a base station and a plurality of mobile terminals via a plurality of channels, wherein:

said plurality of channels include uplink traffic channels for transmitting a data packet from each mobile terminal to said base station, a reservation channel for transmitting a reservation packet representative of a traffic channel allocation request from each mobile terminals to said base station, and an answer channel for transmitting an answer packet indicating an uplink traffic channel via which a data packet is transmitted from said base station to each mobile terminal; and

a spreader that spreads a common transmission power control signal and transmitting said spread common transmission power control signal via said answer channel, said common transmission power control signal containing transmission power control signals of said uplink traffic channels.

7. A spectrum spreading communication system according to claim **6**, wherein:

said answer packet contains an ID of a corresponding mobile terminal which transmitted said reservation packet, information of said uplink traffic channel allocated by said base station, and initial transmission power control information indicating a transmission power when said data packet starts being transmitted; and

said initial transmission power control information is generated in accordance with a reception power of said reservation packet at said base station.

8. A spectrum spreading communication system according to claim **6**, wherein said common transmission power control signal is inserted in said answer channel at a predetermined interval.

9. A base station for communicating with a plurality of mobile terminals by CDMA, comprising:

a reception circuit for receiving a data packet transmitted from each of said plurality of mobile terminals, said plurality of said mobile terminals transmitting over uplink traffic channels to said base station;

a unit for measuring the reception level of said received data packet;

a generator for generating a transmission power control signal in accordance with said measured reception level of said data packet and a common transmission power control signal containing said generated transmission power control signals of said plurality of mobile terminals;

a spreader that spreads said common transmission power control signal; and

a transmission circuit for transmitting said spread common transmission power control signal through a common channel shared by said plurality of mobile terminals.

10. A base station according to claim **9** wherein said reception circuit includes an acquisition/despread circuit for demodulating a spectrum spread signal, and said transmission circuit includes a spreader for spectrum spreading said common transmission power control signal.

11. A base station for communicating with a plurality of mobile terminals by CDMA, comprising:

a reception circuit for receiving a data packet transmitted from each of said plurality of mobile terminals, said plurality of said mobile terminals transmitting over uplink traffic channels to said base station;

a unit for measuring the reception level of said received data packet;

a generator for generating a transmission power control signal in accordance with said measured reception level of said data packet and a common transmission power control signal containing said generated transmission power control signals of said plurality of mobile terminals;

a spreader that spreads said common transmission power control signal; and

a transmission circuit for transmitting said spread common transmission power control signal through a common channel shared by said plurality of mobile terminals, as part of control information.

12. A base station for communicating with a plurality of mobile terminals by CDMA, comprising:

a first reception circuit for receiving a reservation packet representative of a transmission request for a data packet to be transmitted from each of said plurality of mobile terminals, said plurality of said mobile terminals transmitting over uplink traffic channels to said base station;

second reception circuits for receiving data packets transmitted from said plurality of mobile terminals;

a unit for measuring the reception level of said received data packet;

a traffic channel transmission power control signal generator for generating a transmission power control signal in accordance with said measured reception level of said data packet and a common transmission power control signal containing said generated transmission power control signals to be transmitted to said plurality of mobile terminals;

a spreader that spreads said common transmission power control signal; and

a transmission circuit for transmitting said spread common transmission power control signal through a common channel shared by said plurality of mobile terminals.

13. A base station according to claim **12**, wherein said transmission circuit transmits an answer packet indicating a traffic channel via which each mobile terminal transmits said data packet, said answer packet being generated after the interpretation of said reservation packet received by said first reception circuit.

14. A base station according to claim **13**, further comprising:

a unit for measuring the reception level of said received reservation packet; and

a reservation channel transmission power control signal generator for generating an initial transmission power control signal in accordance with said measured reception level of said reservation packet,

wherein said initial transmission power control signal is contained in said answer packet.

15. A mobile terminal for communicating with a base station by CDMA, comprising:

a reception circuit for receiving a common transmission power control signal that is spread by a spreader and transmitted through a common channel shared by a plurality of said mobile terminals from said base station, said common transmission power control signal containing transmission power control signals of said plurality of mobile terminals transmitting over uplink traffic channels to said base station;

a calculator for calculating a gain in accordance with a transmission power control signal destined to the mobile terminal and derived from said spread common transmission power control signal; and

a transmission circuit for transmitting a data packet at a transmission power corresponding to said calculated gain.

16. A mobile terminal for communicating with a base station by CDMA, comprising:

a first reception circuit for receiving a common transmission power control signal through a common channel shared by a plurality of said mobile terminals that is spread by a spreader and transmitted from said base station, said common transmission power control signal containing transmission power control signals of said plurality of mobile terminals, and for receiving an answer packet transmitted from said base station, said answer packet indicating a traffic channel via which the mobile terminal transmits a data packet;

a calculator for calculating a gain in accordance with a transmission power control signal destined to the mobile terminal and derived from said common transmission power control signal; and

a transmission circuit for transmitting said data packet at a transmission power corresponding to said calculated gain via said traffic channel designated by said answer packet.

17. A mobile terminal according to claim 16, wherein said answer packet includes an initial transmission power control signal, said calculator calculates a gain to be used at the start of transmission in accordance with said initial transmission power control signal, and said transmission circuit starts transmitting said data packet at a transmission power corresponding to said calculated gain to be used at the start of transmission.

18. A mobile terminals according to claim 16, further comprising:

a second reception circuit for receiving a control signal transmitted from said base station, a transmission power of said control signal being predetermined;

a unit for measuring the reception level of said control signal; and

a reservation channel gain calculator for calculating a reservation packet gain in accordance with the reception level of said control signal measured by the unit, said reservation packet gain being used for transmitting a reservation packet representative of a transmission request for said data packet,

wherein said transmission circuit transmits said reservation packet at a transmission power corresponding to said reservation packet gain.

19. A mobile terminal for communicating with a base station by spectrum spreading, comprising:

a first reception circuit for receiving a common transmission power control signal transmitted from said base station, said common transmission power control signal containing transmission power control signals of a plurality of mobile terminals, and for receiving an answer packet transmitted from said base station, said answer packet indicating a traffic channel via which the mobile terminal transmits a data packet;

a second reception circuit for receiving said data packet containing said transmission power control signal transmitted from said base station;

a switch for switching a connection to a gain calculator between said first reception circuit and said second reception circuit; and

a transmission circuit for transmitting said data packet at a transmission power corresponding to the gain calculated by said gain calculator via the traffic channel designated by said answer packet,

wherein said gain calculator calculates the gain in accordance with said common transmission power control signal or said transmission power control signal derived from said data packet.

20. A mobile terminal according to claim 19, wherein said switch connects said first reception circuit to said gain calculator while the mobile terminal performs one way communication, and connects said second reception circuit to said gain calculator while the mobile terminal performs two way communication.

21. A mobile terminal according to claim 19, wherein said answer packet includes an initial transmission power control signal, said gain calculator calculated a gain to be used for the start of transmission in accordance with said initial transmission power control signal, and said transmission circuit starts transmitting said data packet at a transmission power corresponding to said calculated gain to be used for the start of transmission.

22. A mobile terminal according to claim 19, further comprising:

a second reception circuit for receiving a control signal transmitted from said base station, a transmission power of said control signal being predetermined;

a unit for measuring the reception level of said control signal; and

a reservation channel gain calculator for calculating a reservation packet gain in accordance with the reception level of said control signal measured by the unit, said reservation packet gain being used for transmitting a reservation packet representative of a transmission request for said data packet,

wherein said transmission circuit transmits said reservation packet at a transmission power corresponding to said reservation packet gain.

23. A transmission power control method for a CDMA communication system which performs communication between a base station and a plurality of mobile terminals by CDMA, wherein:

a plurality of said mobile terminals transmit over uplink traffic channels to said base station;

said base station spreading a common transmission power control signal with a spreader, and transmitting said spread common transmission power control signal through a common channel shared by said mobile terminals; said common transmission power control signal containing transmission power control signals of said plurality of mobile terminals; and

each of said plurality of mobile terminals receives said common transmission power control signal, derives a corresponding one of said transmission power control signals destined thereto from said common transmission power control signal, and controls the transmission power of a signal to be transmitted to said base station in accordance with said derived transmission power control signal.

24. A transmission power control method for a CDMA communication system which performs communication between a base station and a plurality of mobile terminals by spectrum spreading, wherein:

a plurality of said mobile terminals transmit over uplink traffic channels to said base station;

said base station spreads a common transmission power control signal with a spreader, and transmits said com-

mon transmission power control signal through a common channel shared by said mobile terminals; said common transmission power control signal containing transmission power control signals of mobile terminals performing one way communication, and said base station transmits a transmission signal containing a transmission power control signal of a mobile station performing two way communication thereto; and

each of said plurality of mobile terminals receives said common transmission power control signal or said transmission signal, derives a corresponding one of said transmission power control signals destined thereto from said common transmission power control signal or from said transmission signal, and controls the transmission power of a signal to be transmitted to said base station in accordance with said derived transmission power control signal.

25. A base station for communicating with a plurality of mobile terminals by CDMA, comprising:

a plurality of said mobile terminals transmit over uplink traffic channels to said base station;

a generator for generating a transmission power control signal and a common transmission power control signal containing said generated transmission power control signals of said plurality of mobile terminals; and

a spreader for spreading said common transmission power control signal;

a transmission circuit for transmitting said spread common transmission power control signal to said plurality of mobile terminals.

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